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Design & Development of Algorithms to Diagnose Secondary Diabetic Retinopathy Glaucoma through the Analysis of Fundus Images Using IP Techniques

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ABSTRACT: A brief review of the concepts relating to the glaucoma disease, its detection, etc... & its types are being presented in this paper analysis of fundus images using IP techniques.

KEYWORDS: Glaucoma, Secondary, RNFL, Image, Diabetics, Retinopathy.

I. INTRODUCTION

Glaucoma damages the optic nerve which leads to permanent blindness. It cannot be cured, so detecting the disease in time is very important. Glaucoma is one of the most severe eye diseases according to the number of blindness causes in India and western countries and is the second most leading eye disease. Therefore, the early detection, long-term monitoring of the patients and the decision about the appropriate therapy at the correct time are the serious tasks for the ophthalmologist. This earlier detection of deadly diseases has been proposed using advanced image processing, analysis and recognition techniques. This state of art techniques had already been assisted doctors in various fields such as earlier detection and diagnosis of diseases, clinical decisions, remote sensing surgeries and so forth. In short to say, glaucoma is a chronic eye disease in which optic nerve is progressively damaged & slowly starts to cause sight loss.

In its early stages, there is no pain and patients often have no symptoms. Over time glaucoma starts to affect your side/peripheral vision and slowly works its way to the middle if left undetected. According to World Health Organization (WHO), Glaucoma is the second leading cause of vision loss; that contributes to approximately 5.2 million cases of blindness (15% of total blindness cases reported) and can potentially affect ~80 million people in the next decade. To date, there is no cure for glaucoma. Fortunately, it is usually a slow progressing condition, and if it is detected early, it can be treated successfully. Early detection is the key for preventing sight loss. It is characterized by the progressive degeneration of optic nerve fibers and leads to structural changes of the optic nerve head, which is known as optic disk, the nerve fiber layer and a simultaneous functional failure of the visual field. Progression of the disease leads to loss of vision, which occurs gradually over a long period of time.

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Glaucoma cannot be cured, but its progression can be slowed down by treatment. Therefore, detecting glaucoma in time is critical. However, many glaucoma patients are unaware of the disease until it has reached its advanced stage. In India, there are now an estimated 12 million people affected by glaucoma, the majority of whom are undiagnosed. By 2020, this is expected to be 16 million. Since glaucoma progresses with few signs or symptoms and the vision loss from glaucoma is irreversible, screening of people at high risk for the disease is vital. The difference between the normal eye & the affected eye is shown in the Fig. 1 & 2 respectively. The Fig. 3 shows the enlarged view of the normal eye & the affected eye with glaucoma.

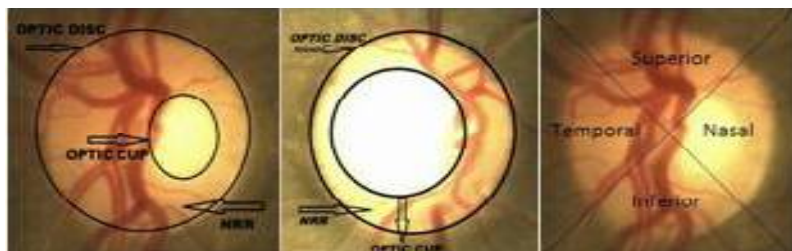


Fig. 1: Normal Disc, Glaucomatotic Disc, ISNT Quadrants

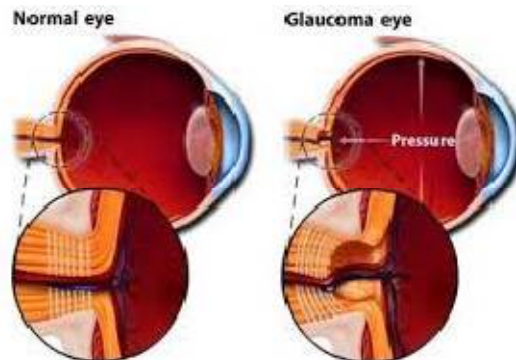


Fig. 2 :Medical image of normal and affected eye

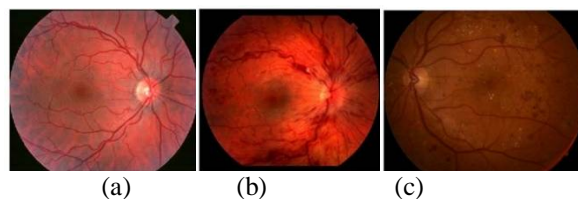


Fig. 3 : Enlarged view of normal & affected eye with glaucoma (diabetes)
(a) Normal non-glaucoma eye (b) Neo-vascular glaucoma affected eye (c) Diabetic retina

II. TYPES OF GLAUCOMA

In this section, different types of glaucoma are discussed as below. These are marked by an increase of intraocular pressure (IOP) or pressure inside the eye.

Open-Angle Glaucoma: It is the most common form of glaucoma, accounting for at least 90% of all glaucoma causes & is caused by the slow clogging of the drainage canals, resulting in increased eye pressure it has a wide and open angle between the iris and cornea it develops slowly and is a long life condition its symptoms and damages are not noticed. Open-angle means that the angle where the iris meets the cornea is as wide and open as it should be Open-angle glaucoma is also called primary or chronic glaucoma.



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Angle-Closure Glaucoma: It is a less common form of glaucoma & is caused by blocked drainage canals, resulting in a sudden rise in intraocular pressure it has a closed or narrow angle between the iris and cornea Develops very quickly it has symptoms and damage that are usually very noticeable Demands immediate medical attention. It is also called acute glaucoma or narrow angle glaucoma. Unlike open-angle glaucoma, angle-closure glaucoma is a result of the angle between the iris and cornea closing.

Normal Tension Glaucoma: It is also called as low tension or normal-pressure glaucoma. It is a form of glaucoma in which damage occurs to the optic nerve without eye pressure exceeding the normal range (10-20mmHg).

Congenital Glaucoma: This type of glaucoma occurs in babies when there is incorrect or incomplete development of the eye's drainage canals during the parental period. This is a rare condition that may be inherited. It is also referred as childhood glaucoma, pediatric or infantile glaucoma. It is usually diagnosed within the first year of baby life.

Primary Glaucoma : The primary glaucoma is mainly due to increase in the Intra Ocular Pressure (IOP). The regions affected are Optic cup, Optic Nerve Head, Neuro retinal Rim and Retinal Nerve Fiber Layer.

Secondary Glaucoma : Secondary glaucoma (SG) arises due to certain complicated conditions like serious eye injury, tumour, diabetes, etc. Neo-vascular glaucoma is a type of secondary glaucoma which is a resultant of Diabetic Retinopathy.

Neo-vascular glaucoma : Neo-vascular glaucoma is caused by the abnormal formation of new blood vessels on the iris and over the eye's drainage channels. Neo-vascular glaucoma is always associated with diabetes. It never occurs on its own. The new blood vessels block the eye's fluid from exiting through the trabecular meshwork causing an increase in eye pressure.

Exfoliate Glaucoma : occurs when a flaky, dandruff-like material peels off the outer layer of the lens within the eye. The material collects in the angle between the cornea and iris and can clog the drainage system of the eye, causing eye pressure to rise.

Pigmentary Glaucoma: occurs when the pigment granules that are in the back of the iris break into the clear fluid produced inside the eye. These tiny pigment granules flow toward the drainage canals in the eye and slowly clog them, causing eye pressure to rise.

A brief review of the various types of glaucoma was discussed in the previous sections. In this context, we are going to find out the CDR for healthy & unhealthy images along with the establishment of some relationships between various parameters.

III. DETECTION OF GLAUCOMA & ITS ASSOCIATED DRAWBACKS

The following sections discuss the conventional methods for glaucoma detection and the associated drawbacks.

In the following sections, we give a brief review about the secondary glaucoma.

Secondary Glaucoma (SG) : Secondary glaucoma arises due to certain complicated conditions like serious eye injury, tumour, diabetes, etc. Neovascular glaucoma is a type of secondary glaucoma which is a resultant of Diabetic Retinopathy. Detailed study of Neovascular Glaucoma and Diabetic Retinopathy is explained in the following sections.

Neovascular Glaucoma : Neovascular Glaucoma (NVG), the word literally means building new vessels which causes ocular disorders. NVG is the severe state of glaucoma which may lead to permanent loss of vision if not treated early. Weiss and his colleagues gave the name for the first time in 1963. This is caused due to the insufficient pumping of oxygen and glucose to the retina. As a result retina starts building new blood vessels in wrong places (anterior



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chamber angle) to keep the tissues alive. These new blood vessels block the aqueous outflow. The new vessels are accompanied by fibrous membrane which on contradiction may result in peripheral anterior to progressive angle closure. This increases the pressure in the eye which may lead to blindness. The ocular diseases like Neo-Vascularisation (NV) of iris (NVI) or neo-vascularisation of angle may finally lead to neovascular glaucoma. The patients suffering from Diabetes Mellitus (DM) are more prone to NVG since the blood flow is less in diabetic patients.

Diabetic Retinopathy : Diabetic retinopathy is a condition occurring in individuals associated with diabetes, which causes damage of retina progressively. The blood vessels that nourish retina are damaged due to prolonged and uncontrolled diabetes, finally leading to diabetic retinopathy. These impaired blood vessels leak blood and other fluids that cause swelling of retinal tissue and clouding of vision. Background or Non Proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic Retinopathy (PDR) are the two types of diabetic retinopathy. NPDR results in a variety of diseased conditions in eye which includes microaneurysms, retinal hemorrhages, hard exudates, macular edema and macular ischemia. PDR results in vitreous hemorrhage, traction retinal detachment and neovascular glaucoma. Such conditions usually affect both eyes causing blindness, if left untreated.

IV. MEDICAL IMAGE (MI) ANALYSIS USING FRACTAL THEORY

Benoit B Mandelbrot has introduced the theory of fractals to illustrate the complexity of natural objects. Fractal analysis has been extensively adopted in a variety of scientific areas including medical Image Processing (IP). The Fractal Dimension (FD) describes the information about the geometric structures of natural objects. Several natural objects exhibit self similarity property over a range of scales allowing them to be illustrated by a FD. As medical images are complex in nature and show various self similarity properties in different scales, FD has been adopted to extract various features. Also Fractal dimension play a key role in several areas of medical research such as distinguishing affected tissues from healthy tissues. Recent progress in the study of fractal theory suggests some attractive solutions for detecting and diagnosing several diseases through fractal dimension techniques. It is also been effectively adopted in differentiating the structural changes in breast cancer and brain images.

The fact that fractal dimension is insensitive to image scaling has motivated us to apply the concept of fractal dimension for the analysis of fundus retinal images (RI). It is also noticed that fractal dimension showed a strong correlation with roughness of surface. Additionally, fractal dimension has been proved as a very powerful tool for quantitative classification of noisy medical images whose edges are generally not clear.

V. CONCLUSION

A brief review of the work related to the PG project undertaken was depicted in the previous sections in the form of introduction, followed by literature survey. The objectives of the project work was also explored & arrived at the definition of the problem that had to be tackled with. Methodology is proposed in the form of a block diagram to solve the above defined problem using Matlab and to arrive at the expected results in our future works.

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